Automated Vehicle Identification Tags in San Antonio

Lessons Learned from the Metropolitan Model Deployment Initiative

Unique Method for Collecting Arterial Travel Speed Information

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Prepared by

Science Applications International Corporation
for further information please contact
Mark Carter
Enterprise Center
P.O. Box 50132
8301 Greensboro Drive
McLean, Virgina 22101-3600
202-366-2196
carterm@saic.com

Preface

This report demonstrates a unique solution to the challenge of providing accurate, timely estimates of arterial travel times to the motoring public. In particular, it discusses the lessons learned in deploying the Vehicle Tag Project in San Antonio, Texas, as part of the Metropolitan Model Deployment Initiative (MMDI).

As one of four sites participating in the MMDI effort, San Antonio was committed to pursuing integrated deployments of Intelligent Transportation Systems (ITS) designed to address gaps in existing traveler services and to provide improvements in areas such as customer satisfaction, safety, and mobility. Of these gaps, the one receiving perhaps the most attention under the effort was in the quality and coverage of critical traveler information systems.

Currently, there are many deployments of advanced traveler information systems around the country. To date, however, most have been lacking in at least one very critical element. While many systems do a good job at describing the latest freeway conditions, few, if any, provide adequate information about conditions on the surrounding arterials. Furthermore, they have been particularly deficient in providing travel times for those critical networks — in answering that important question for the traveler: how long?

San Antonio attempted to address this shortcoming through the collection of travel speed data derived from a series of readers and voluntarily distributed vehicle tags. Subsequent evaluation revealed that while the system functioned well and provided accurate speed information, an appropriate level of market penetration was never reached. This report details the lessons learned from this deployment and describes how a vehicle tag system can be successful in virtually any metropolitan area.

Arterial Travel Information

The provision of traveler information is becoming increasingly important as travelers are beginning to expect reliable, up-to-the-minute information on traffic conditions that may affect their commutes. Currently, however, most Advanced Traveler Information Systems (ATISs) rely on data collected to serve other informational needs (e.g., traffic management functions). Traveler information that is provided most often includes only major freeway traffic conditions because these freeways are already under surveillance to support other functions, such as incident management.

The argument could be made that some information is better than no information; however, surveys indicate that drivers want expanded information on freeways and arterials. In a recent survey in Seattle, more than 57 percent of respondents suggested adding more major roadways and arterials to existing traveler information systems. There were similar requests in Phoenix and San Antonio. In addition, modeling shows that adding arterial information to existing ATIS services can reduce delay. Results from simulation modeling from the Seattle MMDI evaluation showed that adding arterial information reduced system delay by an additional 1.9 percent (from 1.5 percent to 3.4 percent) and the number of stops by an additional 5.6 percent.[1] Similar modeling was performed in San Antonio that showed ATIS users could reduce delay an additional 5 to 8 percent with the addition of arterial information to the existing service.

According to the National ITS Deployment Tracking Database for 1999, 54 of the 78 largest metropolitan areas have some form of arterial surveillance. However, this surveillance is predominately in the form of loop detectors that are often inappropriate to support ATIS functions.

San Antonio attempted to solve this dilemma in its Vehicle Tag Project. By distributing vehicle tags to drivers on a voluntary basis and placing tag readers along arterial roadways, San Antonio hoped to add arterial travel times/speeds to its traveler information systems. Although the Vehicle Tag Project never quite met expectations, the project has merit and might be successful based on the lessons learned in San Antonio during its deployment. This report presents the challenges faced in implementing the Vehicle Tag Project and demonstrates how such a project might be successful in other cities — and in San Antonio.

Vehicle Tags: A Possible Method for Collecting Arterial Information

San Antonio wanted to add arterial travel speeds to improve its existing traveler information system. The addition of such information would address the desire of the public, who had expressed through surveys in Phoenix, Seattle, and San Antonio that arterial information should be added to traveler information systems. This information could then be disseminated through various media, the most prominent being Web sites and variable message signs.

Arterial information is traditionally collected using roadside sensors to measure the number and speed of vehicles as they travel past the sensor. The San Antonio project team decided against using roadside sensors because they collect point-speed data. Point-speed data are useful in determining traffic conditions at a particular point, but they are not effective at evaluating the traffic conditions between sensor locations. San Antonio decided to use automatic vehicle identification (AVI) tags to collect arterial information.

The AVI system has the advantage over point-speed sensors in that it measures travel time between two instrumented points. Unlike point-speed data, travel time data account for traffic delays that occur between two points. San Antonio decided to use AVI tags even though it does not have an electronic toll payment system. The tags were distributed on a voluntary basis.

The Selection Process

Initially, the project team planned to use Intelligent Vehicle Registration Tag (IVRT) technology for the AVI system. The IVRT is a tag that is distributed during the annual registration of the vehicle and is embedded within the vehicle inspection tag. Because there were not enough funds to distribute tags to every driver, the IVRT was not feasible. The Texas Department of Motor Vehicles (DMV) could not manually distribute the tags to only Bexar County drivers; therefore, other tag technologies had to be evaluated. Table 1 (following page) shows the features of the various tags surveyed.

San Antonio chose to use the beam AVI tag. The tags work in a manner similar to electronic toll tags and are read as the tag passes under an electronic interrogator mounted on an overhead structure (see Figure 1). The time it takes a vehicle to traverse the distance between two interrogators is measured and the travel speed is calculated. These data can then be transmitted through a dial-up telephone line back to a database that compiles the information to be distributed among various ATIS media.

Figure 1. *Automated Vehicle Identification Conceptual View*[2]

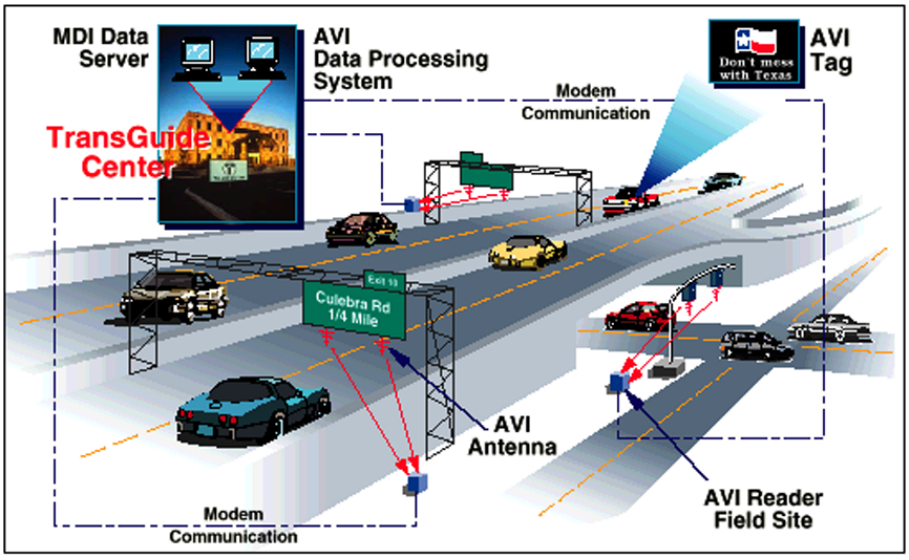


Table 1. *Automated Vehicle Identification Tag Comparisons*[3]

Characteriatics	Priority of the characteristic	Type of Tag		
		IVRT	Toll	Beam
Shelf Life	High; recurring costs very important	Battery-powered; 2 to 5 years	Battery-powered; 5 years	Beam-powered; unlimited
Minimum Quantity	Medium; did not want to order more tags than could be distributed	High; large quantities required to initiate an order	Low	Low
Cost	Medium; initial cost less important than recurring cost	Low; tags contain no intelligence or protective packaging	High; tags contain intelligence to support toll-collection transactions	Medium; tags are passive and contain no intelligence
Adhesion Method	Low	Sticker with adhesive backing attached to windshield	Velcro backing attached to Velcro on windshield	Velcro backing attached to Velcro on windshield
Distribution Method	Medium; some methods face institutional issues	Combined with Texas vehicle registration sticker that is renewed annually	Voluntary	Voluntary

The San Antonio system used 53 electronic interrogators at selected points along 98 miles of major arterials and minor expressways. The interrogators were spaced a mile to several miles apart, as required by the AVI site spacing guidelines (see Table 2).

Table 2. *Automated Vehicle Identification Site Spacing Guidelines*

	Expressways	Arterials
High access	1–3 miles	1–2 miles
Low access	3–5 miles	2–3 miles

Project Costs

The costs of deploying a vehicle tag system to collect arterial travel times/speeds are slightly higher than those for deploying standard loop detectors. The tags were distributed free of charge, but cost almost $15 each. The readers cost about $50,000 each, compared to approximately $10,000 plus installation for a set of two loop detectors per lane for a six-lane road.

Table 3 on the following page represents the costs related to the vehicle tag system, including development costs.

Table 3. *Costs of Automated Vehicle Identification Probe Surveillance*

Equipment Description	Units	Deployment Cost	Yearly Operations and Maintenance Cost
Data Server	1	$ 15,547	
64–Port Modem Server	1	$ 20,122	
TTI Subcontract	na	$ 56,925	
Probe Readers	53	$ 2,364,222	
AVI Tags	78,000	$ 1,129,780	
20 Percent of SWRI Development Labor Costs	na	$ 282,500	
GPS Runs	na	$ 120,000	
Development Labor Costs	na	$ 60,000	
AVI Maintenance	na		$ 32,213
AVI Phone Lines	na		$ 27,726
2 Percent Share of 25 TransGuide Personnel	na		$10,332
2 Percent Share of Software Maintenance and Upgrades	na		$ 2,952
2 Percent Share of Hardware Maintenance and Upgrades	na		$ 467
		$ 4,049,096	$ 73,691

na= not applicable

A Capable System–High Reliability and Accuracy

Several tests were performed to determine the reliability and accuracy of the AVI tags and tag readers. Three tests were run to check the system's reliability, fidelity, and accuracy. The tests and findings are described below.

Overall Reliability Study

The overall system reliability was determined by acquiring and filtering 30 days of tag reader log data to determine which sites failed to report tags at any time. During the study period, 6 of the 53 sites (11.3 percent) experienced downtime for at least 1 day, although no more than 5 sites were down for any single day.

The shortest period of non-functionality for any reader during the test period was one day. The longest period of non-functionality was 25 days. A site downtime-day is defined as one tag reader site being non-functional for a period of one day. The total number of site downtime-days for the system during the test period was 87 out of 1,590 (5.5 percent). The tag reader functionality fluctuated between 90 percent and 100 percent during the 30-day test period. The minimum percentage was 90.6 percent (5 out of 53 sites down) while the highest percentage was 98.1 percent (1 out of 53 sites down).

Controlled Reliability Study

A controlled reliability test was also conducted to evaluate the ability of the tag readers to capture a specific tagged vehicle. In this test, a number of cars equipped with Global Positioning System (GPS) location recorders drove routes along which tag readers were installed. The travel time data collected from these runs were compared to the data collected by the tag readers to see if the control vehicle had been detected. If the vehicle was not detected or was double counted, these were considered "bad reads."
The study looked into a number of factors that could impact the system's reliability. These factors included the facility type (arterial vs. freeway), the geometric configuration of the tag reader antenna (vertical vs. oblique mounting), weather conditions, and vehicle speed under the antenna.

Based on the test runs, there appeared to be a difference in system reliability between arterial and freeway readers. The arterial readers' failure to read tags ranged from 17 to 50 percent, while the freeway readers' failure rate ranged from 5 to 21 percent. Missed reads do not necessarily translate to innaccurate data, but they may necessitate a higher level of market penetration (LMP).

The mounting of the antenna (vertical vs. oblique) did not appear to impact the reliability of the tag reader. A thunderstorm occurred during one of the data collection days, and no impact on the reliability of the tag reader system was detected.

Finally, the test runs indicated a reduction in system reliability as vehicle speed increased. This information is presented in Table 4.

AVI Travel Time Fidelity Analysis

The AVI fidelity test was conducted as part of the controlled reliability study. It involved comparing the travel times recorded from the control GPS vehicle and the travel times computed by the AVI system for that vehicle.

The AVI system was found to estimate travel times to within 2 percent of the GPS estimated travel times in controlled testing. An analysis of various levels of data collection indicated that the level of aggregation had little impact on the accuracy of the travel time estimates.

Technically, the vehicle tag system, based on these tests, has the ability to collect accurate, reliable arterial travel speed information; however, this information can be gathered only if a sufficient number of vehicles are equipped with the tags so that travel time readings can be taken throughout the day.

Table 4. *Tag Capture by Vehicle Speed*

Speed (mph)	Correct Reads	Bad Reads	Total	Percent Correct
0–15	3	0	3	100
16–25	2	1	3	67
26–35	9	1	10	90
36–45	13	3	16	81
46–55	35	1	36	97
56–65	81	9	90	90
TOTAL	143	15	158	91

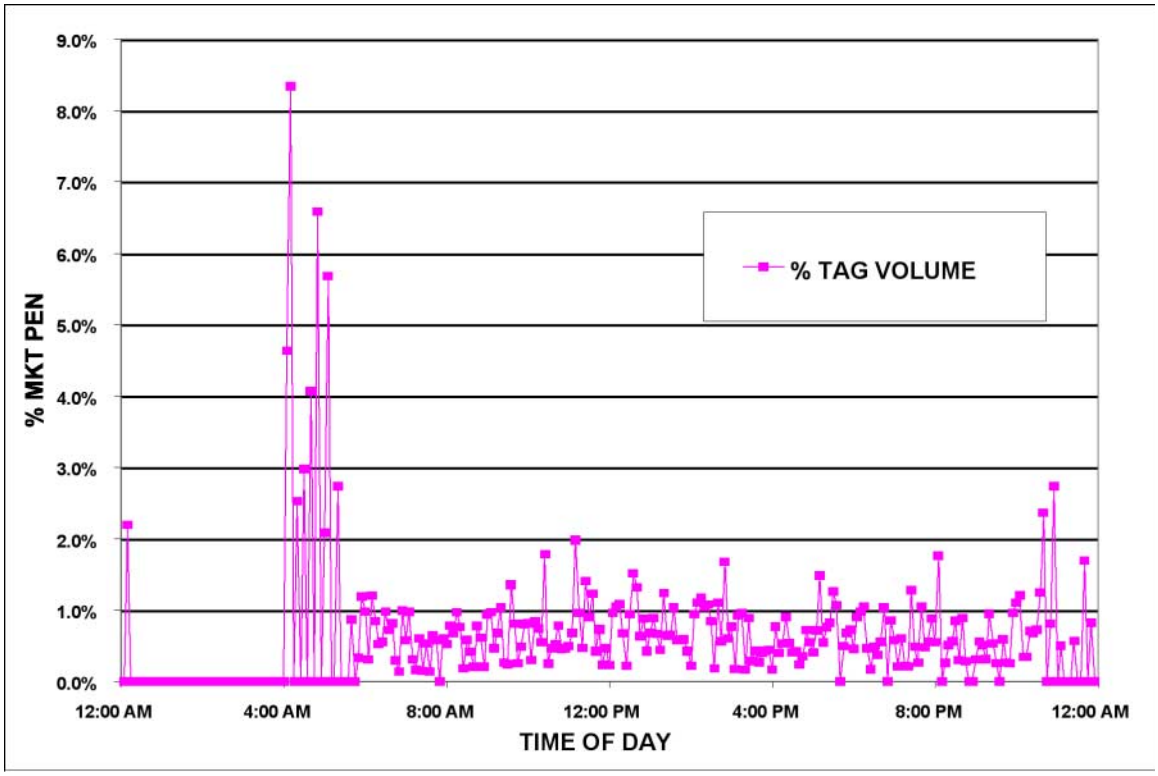
The Problem: Low Market Penetration

To successfully collect arterial travel times using vehicle tags, an adequate number of vehicle tags must be distributed. One common method of vehicle tag distribution is through electronic toll payment; however, San Antonio does not have an electronic toll payment system. The original plans called for more than 400,000 tags to be distributed through the DMV when drivers renewed their vehicle registrations. Unfortunately, this was not possible because of concerns raised by the DMV that it did not have the capability to target only San Antonio area (Bexar County) drivers.

Consequently, the distribution was changed to a voluntary program. Drivers who volunteered to participate got their tags through TransGuide, the local traffic management center, or through their employers, who volunteered to help with the distribution. In all, more than 38,000 drivers volunteered to have the vehicle tags placed on their cars.[4]

San Antonio officials assumed that 38,000 tagged vehicles would provide an adequate level of market penetration; however, this was not the case. The LMP of the tags was computed by counting the number of tags read at a specific reader divided by the total number of vehicles that passed the reader in the same time period. On a typical day, the LMP ranged from 0 to 8.5 percent, with an average LMP of 1 percent or less. More than a quarter of the tags were toll tags from other jurisdictions. The highest LMP occurred between 4:00 and 5:00 A.M., when the total flow was low and the number of trucks was high (trucks are typically equipped with toll tags). Figure 2 shows the LMP for vehicle tags by time of day.

Figure 2. *Level of Market Penetraton for Vehicle Tags by Time of Day*



Although the AVI tags were found to be reliable and to accurately measure travel times during testing, the low LMP made it difficult to measure travel times consistently throughout the day. In addition to the already low number of tags distributed, the arterial reader failure rate, as mentioned earlier, necessitated an even higher LMP.

Consequently, despite their limitations, San Antonio has now decided to use inductive loop detectors and point-source detectors to capture speeds on arterials and minor expressways instead of AVI tags. This decision stems from the failure to attain a significant LMP with the AVI tags. However, several lessons can be learned from the experience to help ensure success with vehicle tags in San Antonio or elsewhere.

Lessons Learned

- Distribute tags in a way that will reach the most drivers. San Antonio's first choice was to distribute tags through the DMV, but this was not possible because of problems at the DMV in targeting a specific group of drivers. However, this distribution method may be successful at other locations.

- Consider using electronic toll tags. If electronic toll payment is employed in an area, these tags can be used to collect travel times. Electronic toll tags are not used in San Antonio; therefore, the city did not have this option.

The public seems to want arterial information to supplement the major freeway traveler information that is generally provided. One method of collecting this information is by using vehicle tags and readers to measure travel times. San Antonio's experience has shown that vehicle tags are technically able to collect accurate and reliable arterial travel times, but only if an adequate LMP is achieved.

[1] Jensen, Mark, "Seattle MMDI Evaluation Report," May 2000, Federal Highways Administration.

[2] "TransGuide Model Deployment Initiative Design Report," Southwest Research Center, 1998, p.11.

[3] "TransGuide Model Deployment Initiative Design Report," Southwest Research Center, 1998, p.17.

[4] It should be noted that tags were assigned a random ID code, instead of any identifying information about the driver, in order to protect drivers' privacy.

ITS Web Resources

ITS Joint Program Office:

http://www.its.dot.gov

ITS Cooperative Deployment Network (ICDN):

http://www.nawgits.com/jpo/icdn.html

ITS Electronic Document Library (EDL):

http://www.its.dot.gov/welcome.htm

ITS Professional Capacity Building Program Catalogue:

http://www.its.dot.gov/pcb/98catalg.htm

Federal Transit Administration:

http://www.fta.dot.gov

Intelligent Transportation Systems

U.S. Department of Transportation
400 7th Street, SW
Washington, D.C. 20590